Clinical Medicine

Intraluminal Thrombosis of Coronary Arteries in Fatal Myocardial Infarctions and in Failed Aortocoronary Saphenous Vein Grafts

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A review of autopsies of 648 patients who died of acute myocardial infarction showed the presence of intraluminal thrombi in 314 (48%). The left anterior descending coronary artery was principally involved in 172 cases, the left circumflex in 30, and the right coronary in 112. The length of survival after admission was identical for patients with thrombotic occlusion and those with atherosclerotic occlusion or severe stenosis: 28% of the former and 29% of the latter died during the first 24 hours after admission. The incidence of intraluminal thrombotic occlusion of surgically excised, failed aortocoronary vein grafts was 42 (66%) in 64 patients with nonfibrotic, patent grafts. Most of these vessels were severely atherosclerotic. The presence of intraluminal thrombi in about half of patients who died of acute myocardial infarction and in two thirds of excised, nonfibrotic, previously patent vein grafts indicates how many patients may benefit from thrombolytic therapy.

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Since the initial clinical-pathologic correlation of coronary artery thrombosis and acute myocardial infarction in 1912 by Herrick,[1] the significance of coronary artery thrombosis has been well recognized and has been the subject of numerous studies. Reports in the 1960s and early 1970s[2-4] that coronary artery thrombosis may be the result rather than the cause of myocardial infarction may have delayed the use of thrombolytic agents in the treatment of early acute myocardial infarction.[5] The current concept is again that thrombotic coronary artery occlusion, usually complicating atheromatous plaques, is frequently the cause of transmural and, less often, subendocardial infarction.[6] It is generally held that significant narrowing of a coronary artery by an atheromatous plaque causes angina and that acute ischemic syndromes are initiated by plaque injury. With intraluminal thrombosis, acute myocardial infarction may develop.[7] It has been reported that the vast majority of patients with acute myocardial infarction during the first hours have a coronary artery that is totally occluded, usually by a thrombus,[8] and that most patients who die in less than six hours have an intraluminal thrombus.[9] If intraluminal thrombosis is indeed a common or perhaps the most common cause of acute infarction, thrombolytic therapy should be beneficial although it may not be effective in patients with the also common intraintimal hemorrhages into a damaged atheromatous plaque[9] and in those with atheromatous stenosis or occlusion without thrombosis.

At the same time, the examination of surgically excised, failed, aortocoronary saphenous vein bypass grafts in this laboratory[10] and elsewhere[11,12] has revealed a high incidence of thrombotic occlusion. Patients who underwent a coronary artery bypass operation in the past and again become symptomatic may therefore also benefit from thrombolytic therapy.

To determine the incidence of intraluminal thrombosis in the coronary arteries of patients who died after hospital admission of acute myocardial infarction and in the surgically excised, failed aortocoronary bypass grafts of patients who underwent a repeat coronary artery bypass graft procedure, the records and slides from these cases were reviewed.

Patients and Methods

The autopsy protocols of all patients who died of acute myocardial infarction at the Hospital of the Good Samaritan (Los Angeles) from January 1, 1953, to November 30, 1987, were reviewed. Patients who had had previous vein grafts or other cardiac surgical procedures were excluded. The site and degree of stenosis were recorded for the principal coronary arteries. Whether the occlusion was caused by thrombosis or by atherosclerotic changes was noted. All sections of the coronary arteries were examined. The number of available sections varied, but the gross descriptions and microscopic findings allowed a classification in each case. Narrowing of 75% or more was considered severe stenosis. The presence of intraluminal or intraintimal and plaque hemorrhage was noted, and the duration of a patient's survival after admission to hospital was recorded and tabulated.

The sections of all aortocoronary saphenous vein bypass grafts that had been surgically excised between July 1, 1971, and August 30, 1987, were also examined. Not all failed grafts were excised during repeat coronary artery bypass graft procedures, but cross sections from all excised vessels

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were available, and most have been sectioned in toto. The pathologic findings were categorized and the incidence of intraluminal thrombosis was noted in relation to the underlying pathologic changes in the vessel wall.

Results

A total of 648 autopsies of fatal cases of acute myocardial infarction were reviewed. The gross and microscopic findings were of intraluminal coronary artery thrombosis in 314, or 48% of the cases. Cases of sudden death that occurred before the patient could be admitted are not included, but the review shows that 28% of the deaths occurred during the first 24 hours after admission, 39% during the second to seventh day, and about a third after seven days or longer (Table 1). There was no appreciable difference in the length of survival between patients with coronary artery thrombosis and those with atherosclerotic occlusion or severe stenosis, and, conversely, there was no difference in the incidence of thrombosis between patients who died soon after admission and those who survived for a week or longer.

Only cases in which thrombotic material was present within the remaining generally stenosed lumina were classified as showing thrombosis. Many other cases showed the presence of old or recent hematomas within plaques but no associated intraluminal thrombosis. These were categorized as atherosclerotic lesions.

As Table 2 shows, the left anterior descending coronary artery was involved by intraluminal thrombosis in 172 cases, or 55%. This percentage was even higher (73%) in the category of atherosclerotic stenosis or occlusion. In 193 (79%) of these cases, one or more additional major vessels were significantly diseased. The decision as to which vessel was principally involved was based on the degree of vascular occlusion and at times the location of the infarction. The left main coronary artery was involved in some cases but never in a case of single-vessel disease.

In all, 119 surgically excised aortocoronary saphenous vein bypass grafts from 83 patients were examined. The most significant and advanced lesions, including those specifically of intraluminal thrombosis, were recorded. In 19 of the 83 patients, the vein grafts were occluded by fibrous tissue, either as a consequence of early thrombosis soon after the initial surgical procedure or possibly by progressive intimal fibrosis.[10] In ten cases, the vessels showed fibrointimal circumferential proliferation without atherosclerotic changes and were occluded by thrombi. In 32 of 54 cases, the grafts were involved by severe atherosclerosis and were completely occluded by intraluminal thrombi. Overall, 42 of 64 grafts (66%) that were not occluded by fibrosis did contain recently formed thrombi.

The two groups of cases are not clinically comparable. All autopsies were done in cases of acute myocardial infarction. Most patients with failed bypass grafts had angina as their principal symptom. Of 30 patients in whom the clinical findings were analyzed, 17 had stable angina, and 7 other patients had unstable angina. Only three had suffered a myocardial infarction during the three months preceding the operation. Despite this heterogeneity, thrombosis was a frequent and important finding in both groups.

TABLE 1.—*Coronary Artery Lesions in Fatal Acute Myocardial Infarctions*

Lesion	Total		Survival			
	Number	(Percent)	<24 h	24-72 h	3-7 d	>7 d
Intraluminal thrombotic occlusion	314	(48%)	87	62	61	104
Atherosclerotic occlusion or severe stenosis	334	(52%)	98	66	63	107
All cases	648		185	128	124	211

Comment

The presence of intraluminal thrombi in 48% of our 648 autopsy cases of fatal acute myocardial infarction is similar to that reported in the literature, with a range of 38% to 54% in various series.[13] This is considerably less than the incidence of thrombosis assumed to be present in early stages of acute myocardial infarction based on angiographic studies.[8,13] Our cases do not include patients who died before they could be admitted to hospital but neither do reported cases that were examined by angiography. The fact that in our series the incidence of thrombosis was the same in patients who died within 24 hours and those who survived for several days raises questions about the reported high rate of thrombosis during the first hours of infarction. Earlier reports actually indicated a lower rate of thrombosis in early stages of myocardial infarction,[2] an observation that has not been substantiated by subsequent studies.[6]

The incidence of intraluminal thrombosis in surgically excised aortocoronary saphenous vein bypass grafts in our series is higher than that generally reported in the literature.[11,12,14]

It is important to keep in mind that thrombosis in coronary arteries and in most vein grafts is intimately associated with and generally is a complication of advanced atherosclerosis.[6,7] It has been proposed that coronary artery thrombosis may be due to spasms.[8,13] This may be the case, but there is unequivocal morphologic evidence that most intraluminal thrombi are associated with plaque injury such as intraplaque or intraintimal hemorrhage, fissuring, or rupture.[6,7,9,15] Sections frequently show an admixture of atheromatous material with an intraluminal thrombus. This may make it difficult to distinguish morphologically an actual intraluminal thrombus from hemorrhage into an atheromatous plaque. Such a distinction is, however, important to determine or at least estimate how many patients might benefit from thrombolytic therapy. Prompt treatment with tissue plasminogen activator is now widely advocated and is given

TABLE 2.—*Principal Involvement of Major Coronary Arteries*

Coronary Artery	Thrombosis, Number	Multivessel Disease, Number	(Percent)	Atherosclerosis, Number	Multivessel Disease, Number	(Percent)
Left anterior descending	172	91	(53)	245	193	(79)
Left circumflex	30	20	(67)	24	15	(62)
Right coronary	112	69	(62)	65	41	(63)

without a preceding arteriography.[16] It is doubtful that such therapy is effective in cases of "intraintimal" hemorrhage or thrombus.[9] Based on the review of the large number of cases in our series, it appears that thrombolytic therapy might have been effective in approximately half of our patients with acute myocardial infarction.

Studies of surgically excised aortocoronary saphenous vein bypass grafts show the development of atherosclerosis at a much more rapid rate than is seen in coronary arteries where significant atherosclerotic changes generally do not appear before the fourth decade. Smooth muscle cells, some including lipid vacuoles that correspond to early atherosclerotic changes in fatty streaks, were found in the thickened intima of grafted veins by electron microscope after 21 months,[17] and advanced atherosclerotic lesions were reported in grafted veins after 16 and 29 months.[17,18] Significant atherosclerosis usually develops five years after the placement of veins in the arterial circulation,[10,11] and failure of the grafts and recurrent angina or myocardial infarction are frequently associated with this process. The thrombosis in vein grafts that had undergone atherosclerotic changes was demonstrably associated with fissured or ruptured plaques and often with intraintimal hemorrhage into atheromas.[10] Thrombolytic therapy may therefore be indicated in these patients as well as in those with acute myocardial infarction.

REFERENCES

1. Herrick JB: Clinical features of sudden obstruction of the coronary arteries. JAMA 1912; 59:2015

2. Spain DM, Bradess VA: The relationship of coronary thrombosis to coronary atherosclerosis and ischemic heart disease. Am J Med Sci 1960; 240:701-710

3. Roberts WC, Buja LM: The frequency and significance of coronary arterial thrombi and other observations in fatal acute myocardial infarction—A study of 107 necropsy patients. Am J Med 1972; 52:425-443

4. Muller JE: Coronary artery thrombosis: Historical aspects. J Am Coll Cardiol 1983; 1:893-896

5. Hugenholtz PG: Acute coronary artery obstruction in myocardial infarction: Overview of thrombolytic therapy. J Am Coll Cardiol 1987; 9:1375-1384

6. Saffitz JE, Schwartz CJ: Coronary atherosclerosis and thrombosis underlying acute myocardial infarction. Cardiol Clin 1987; 5:21-30

7. Feldman RL: Coronary thrombosis, coronary spasm and coronary atherosclerosis and speculation on the link between unstable angina and acute myocardial infarction. Am J Cardiol 1987; 59:1187-1190

8. Dalen JE, Ockane JS, Alpert JS: Coronary spasm, coronary thrombosis, and myocardial infarction: A hypothesis concerning the pathophysiology of acute myocardial infarction. Am Heart J 1982; 104:1119-1124

9. Davies MJ, Thomas A: Thrombosis and acute coronary-artery lesions in sudden cardiac ischemic death. N Engl J Med 1984; 310:1137-1140

10. Kern WH, Wells WJ, Meyer BW: The pathology of surgically excised aortocoronary saphenous vein bypass grafts. Am J Surg Pathol 1981; 5:491-496

11. Walts A, Fishbein MC, Matloff JM: Thrombosed, ruptured and atheromatous plaques in saphenous vein coronary artery bypass grafts: Ten years' experience. Am Heart J 1987; 114:718-723

12. Bourassa MG, Campeau L, Lespérance J, et al: Atherosclerosis after coronary artery bypass surgery: Results of recent studies and recommendations regarding prevention. Cardiology 1986; 73:259-268

13. Luchi RJ, Chahine RA: Coronary artery spasm, coronary artery thrombosis, and myocardial infarction. Ann Intern Med 1981; 95:502-505

14. Atkinson JB, Forman MB, Vaughn WK, et al: Morphologic changes in long-term saphenous vein bypass grafts. Chest 1985; 88:341-348

15. Yutani C, Ishibashi-Ueda H, Konishi M, et al: Histopathological study of acute myocardial infarction and pathoetiology of coronary thrombosis—A comparative study in four districts in Japan. Jpn Circ J 1987; 51:352-361

16. James TN: Cascades, collusions and conflicts in cardiology (Editorial). JAMA 1988; 259:2454-2455

17. Kern WH, Dermer GB, Lindesmith GG: The intimal proliferation in aortic-coronary saphenous vein grafts. Am Heart J 1972; 84:771-777

18. Hanlon JT, Massie B, Riches W, et al: Rapidly progressive coronary artery bypass graft atherosclerosis. Chest 1981; 79:96-99